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level. (5) The deposition of the Cambrian "Tonto sandstone" (which, however, did not cover all of the Proterozoic monadnock), succeeded by the accumulation of the "Tonto shale," "Red Wall limestone" and later Paleozoic formations.

It is clear that the present vertical distance between the pre-Tonto and pre-Unkar unconformities affords only a minimum measure of the throw of the pre-Cambrian faults. That there has been some slight post-Paleozoic movement along the Bright Angel fault, enough to fissure the "Red Wall" and "Aubrey" formations, is shown by the erosion of the Bright Angel gorge, the alcove of Indian Garden, and the shallow drainage trench followed by the Grand Canyon Railroad near the southern rim of the canyon. As may be seen from the Bright Angel topographic sheet of the U. S. Geological Survey, the three features mentioned together constitute a remarkable rectilinear depression at least 20 miles in length. F. L. RANSOME

WASHINGTON, D. C.

AN EARLY FIGURE OF THE KING-CRAB (*LIMULUS POLYPHEMUS*)

THERE has recently been placed on exhibition in the gallery of arthropoda in the Zoological department of the British Museum a copy of a water-color drawing made about 1585 and containing what is believed to be the earliest representation of the American king-crab (*Limulus*, or *Xiphosura*, *polyphemus*). As the subject is one of special interest to American naturalists, it may be worth while to place on record here some of the facts relating to it.

The original drawing was made by John White, who was one of the first settlers in, and for some time governor of, Virginia, and acted as lieutenant to Sir Walter Raleigh on several voyages to North America. Three volumes of drawings by him are preserved in the Department of Prints and Drawings in the British Museum, and have recently been described in detail by Mr. Laurence Binyon in the fourth volume of his "Catalogue of Drawings by British Artists . . . in the

British Museum" (1907, pp. 326-337). Many of White's delineations of natural objects are of great beauty and show a fidelity to nature which was very rare at the period when they were executed.

The drawing in which the figures of the king-crab are introduced is a view of Indians spearing fish, and two specimens of *Limulus* are roughly but quite unmistakably sketched among shells and other marine objects lying on the beach in the foreground. Like many of White's drawings this one was engraved for de Bry's "America" in 1590. In the engraving the figures of the king-crabs, like some other portions of the picture, are drawn in somewhat greater detail, suggesting that the engraver was working from some other drawing now lost. As Mr. Binyon suggests, "doubtless White made many repetitions of drawings which would have such lively interest for his countrymen." In de Bry's volume the text accompanying these drawings is a translation of Thomas Harriot's "A Brief and True Report of the New Found Land of Virginia, &c.," first published in 1588 and afterwards reprinted in Hakluyt's "The Principal Navigations, &c." in 1598 (the following quotation is from the Hakluyt Society's edition, 1904, Vol. VIII., p. 370). In his list of the natural products of Virginia Harriot mentions "Seekanauk, a kinde of crusty shel-fish, which is good meat, about a foot in bredth, having a crusty taile many legges like a crab, and her eyes in her backe. They are found in shallowes of waters and sometime on the shore." This doubtless refers to the king-crab. It would be interesting to know whether any readers of SCIENCE can give a reference to any earlier mention of this animal.

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A PLAN FOR INCREASING THE EFFICIENCY OF MARINE EXPEDITIONS

APART from their work in deep-sea sounding, and in the accumulation of meteorolog-

¹ Grands Voyages, Part I., pl. 13.

ical observations, marine expeditions of the past have been merely extensive collecting trips. Only few and unimportant studies of living forms are possible upon a ship at sea, and practically all of the animals and plants collected are thrown immediately into preservative fluids in order that their more or less distorted remains may be sent ashore for distribution among specialists of research. In anthropology, geography, geology and kindred sciences the results are hardly more satisfactory, for it is only rarely that a vessel can remain in any one port long enough to enable her scientific staff to do more than make a mere reconnaissance.

Yet modern science is being advanced by intensive and accurate, not by extensive and cursory, observations. As time goes on the superficial in science commands less and less of our respect; and yet after an expenditure of millions by all civilized nations upon a score of marine expeditions we find that these projects have achieved practically nothing in the advancement of physiology, embryology, cytology, ecology; or in any studies requiring that plants or animals be maintained alive for any considerable time, or that use be made of the complex processes of experimentation in vogue in the modern laboratory.

My own experience, which results from having been upon many marine expeditions in all of the great oceans, forces me to conclude that not more than one fifth as much work can be accomplished on ship-board as is possible even in a moderately well-equipped land station. Really good days at sea are rare, and too often occur when the vessel must either lie idle, hasten toward some distant port, or be otherwise prevented from carrying out scientific studies. Even if one be not affected by sea-sickness, the constant rolling of the ship, shaking due to engines, and uncertain fluctuations of light in the laboratory are most discouraging to accurate work.

In future let us establish temporary land stations for the scientific staff and use the ship to supply such laboratories with their equipment and with material for study as it travels from station to station in accordance with the requirements of its work.

Only a few years ago such a plan would have been impracticable, but within the past five years the naphtha engine has been so far perfected to marine use, and so many sailors have become trained to its management, that it now gives us an opportunity to provide each temporary land station with a fast-moving collecting boat always ready for immediate service and capable of exploring every detail of coast or ocean current within a radius of many miles.

Moreover, the modern perfecting of easily transported portable houses which can readily be erected on barren shores, and the great variety one may now obtain of preserved foods, render it possible to house and supply investigators in temporary stations in regions which only a few years ago were practically inaccessible.

The marine expeditions of the future should, I think, aim to establish well-equipped but temporary shore stations at salient points, landing investigators here and there and leaving them with servants, food, lodging, apparatus and naphtha launches to avail themselves of all the varied advantages afforded by a land laboratory. In this manner a larger number of investigators than is at present possible could be carried on the expedition; for most of them would make use of the vessel merely for transportation from station to station, and for necessary supplies. A small staff permanently resident upon the steamer itself would suffice for the prosecution of such deep-sea studies as must needs be accomplished while at sea.

There is sufficient room upon any sea-going vessel for the transportation of several portable houses, half a dozen or more naphtha launches, and for collectors, engineers, sailors and cooks required for the service of the various shore stations.

Such a plan would not interfere with the constant use of the ocean-going vessel itself, which could readily carry out her proper scientific work while traveling from station to station, either to remove parties of investigators to other sites or to provide them with specimens or supplies.

We see, then, that this plan has the double

advantage that it enables the expedition to carry many more investigators than if all were to remain constantly on board, as of old; and it also greatly widens the scope and increases the efficiency of their individual researches.

There are many problems, yet awaiting solution, which previous marine expeditions have either been obliged to neglect or have studied in a superficial and unsatisfactory manner. Such are:

1. The determination of the depth of the "red clay" which covers the floor of the deepest parts of the open oceans. Since the oceans ceased to boil this deposit has been gathering upon the floor of the deep sea, and a determination of its depth would enable us to form an approximate estimate of the age of the oceans themselves.

2. The character of and influences affecting ocean currents, especially at considerable depths.

3. The embryology of numerous creatures of the open ocean and of the deep water, such as *Nautilus*, the trachylina medusæ, etc.

4. A more accurate and intensive study of the nature and origin of coral atolls.

5. A more accurate study of the phenomena of oceanic volcanic islands.

6. A comparative study of the distribution of life over the great oceans; both near the surface, and at the bottom, over the open sea and in the neighborhood of coasts.

7. An intensive study of the arts, legends and habits of the native races of relatively inaccessible regions.

8. A more accurate study of meteorological conditions, leading to a more perfect understanding of the nature of the trade winds, tropical hurricanes, etc.

The nature and scope of the problems must, however, be determined by the capacities and training of those constituting the scientific staff of such an expedition. With a wisely selected corps of able, energetic students more might be accomplished upon an expedition planned in accordance with this which we have here crudely outlined, than has resulted from even the most expensively equipped marine expeditions of recent years, all of

which have adhered to the old plan of attempting to constitute of the vessel a floating and traveling laboratory.

ALFRED GOLDSBOROUGH MAYER

THE MARYLAND GEOLOGICAL SURVEY

THE Maryland legislature, which adjourned a few days ago, provided \$1,000,000 for the work of the State Geological Survey during the coming biennial period—\$50,000 for the geological investigations, topographic surveying, and maintenance of the testing laboratory; \$150,000 for the continuation of the construction of the Baltimore-Washington road, and \$800,000 for the work under the State Aid Highway Law, one half of the latter to come from the state treasury and one half from the county treasuries. Under the State Aid Law the roads must be built in accordance with the plans and specifications and under the supervision of the engineers of the Geological Survey.

The Maryland legislature also passed a bill providing for a bond issue of \$5,000,000 for the construction of a main artery system of state highways 1,000 miles in length during the next five years, \$1,000,000 to be available each year. A long and bitter fight developed over the administration of this new fund, the senate desiring it placed in the hands of the State Geological Survey and the house wishing a new commission. Just as the legislative session was closing a compromise was effected by which a new commission of six members was provided for, three to come from the Geological Survey. The understanding reached was that Governor Crothers, President Ira Remsen, of the Johns Hopkins University, and Dr. Wm. Bullock Clark, director of the State Geological Survey, should be selected to represent the survey. It was also agreed that after this new commission had designated the 1,000-mile system the roads should be turned over to the Geological Survey for construction. The leading newspapers of the state, including all of the daily papers of Baltimore, strongly advocated the placing of the work under the Geological Survey, where it would be effectively managed and free from political influ-